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Seismic evaluation of the proposed connection with corner and shield and comparison with pre-approved connections

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ABSTRACT: In steel structures, connections play an important role in the behavior of the structure. In this article, by using numerical modeling with Abaqus finite element software, several different models of beam to steel column connection have been modeled and investigated. This article has investigated the effect of beam-to-column connection with two types of shield and corner connection. Hence, 20 models with different conditions of different thicknesses and different types of hardeners, as well as 6 models with columns filled with concrete, have been investigated and studied. Abaqus finite element software is used for modeling and cyclic load is used for loading. The results show that the model with the shield stiffener had a higher capacity and compared to the corner stiffener, it had a 12-28% higher bending capacity in the connection. By increasing the thickness of the corner or shield of the beam to the column connection, the capacity has increased by about 12 to 25%, in the thickness of 18 mm, the anchor capacity has increased by 12%, and in the thickness of 20 mm, it has been observed to increase by 25%. The column model filled with concrete has a difference of 15-25% compared to the similar model without concrete, and the column model filled with concrete has a higher bearing capacity.

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1- Introduction

Yosoja et al.[1], in an article, have studied the connections of columns filled with concrete. In this study, in the first step, the available literature on the bending strength of circular concrete-filled steel tubes (CFSTs) is reviewed. Using a much larger database of published bending tests than previous review studies, the applicability and conservatism of four common design standards for evaluating the bending capacity of circular CFSTs have been demonstrated through this review. This was confirmed regardless of the type of concrete used to fill the circular CFST. Reliability analysis performed on 219 circular CFST bending tests obtained from the literature confirms that the capacity factors listed for steel and concrete in AS/NZS 2327 provide an adequate level of confidence for structural design.In an article, Nader Fanai et al.[2] studied the behavior of beams to steel columns filled with concrete connection with T-shaped stiffeners. Their research showed the concentration of stress in the connection, which leads to a decrease in flexibility. In this research, two sets of analytical models with fixed and variable holes were investigated. In a study on the seismic behavior of the proposed steel connection with a box-shaped column filled with concrete, the results of these studies showed that the optimal number of holes and the appropriate drilling pattern of the wing of the beam improved the performance and seismic behavior of the connection [3].

2- Methodology

For the column, a box-shaped column section with dimensions of 550 x 550 with a thickness of 20 mm is used, and the width of the I-shaped beam wing bfb = 20 cm, the thickness of the beam flange tfb = 1.6 cm, the thickness of the beam web twb = 1.02 cm, the depth of the beam is db = 50 cm. Table 1 shows the characteristics of beams and columns in the study connection.

The distance between the axes of the columns on both sides of the beam is 5.2 meters. The parameters considered in

Table 1. Specifications of beams and columns

Section	beam	column
Type Section	IPE	Box
Height (mm)	500	550
flange Length (mm)	200	550
flange thickness (mm)	16	20
web thickness (mm)	10.2	20
Material Specifications	St37	St37

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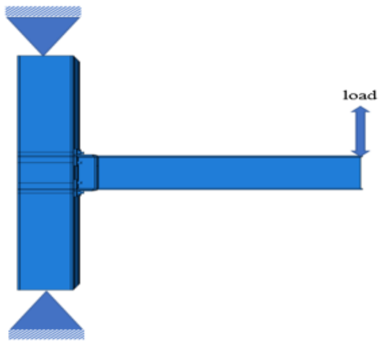

Fig. 1. Support and loading conditions of the studied model

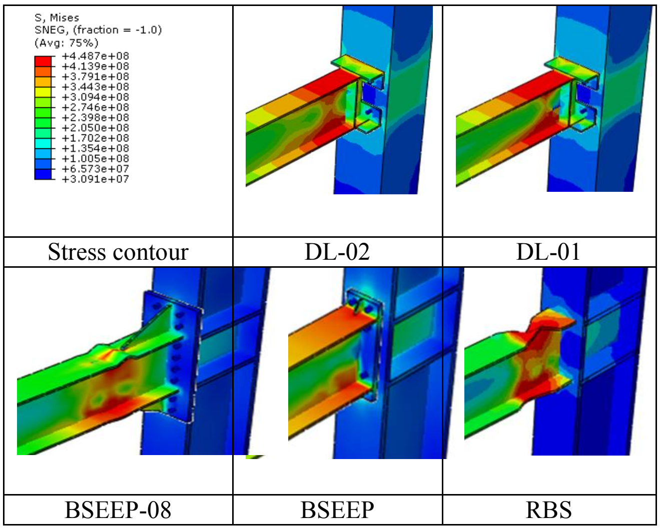

Fig. 2. Von Mises stress (unit of stress is N/m2)

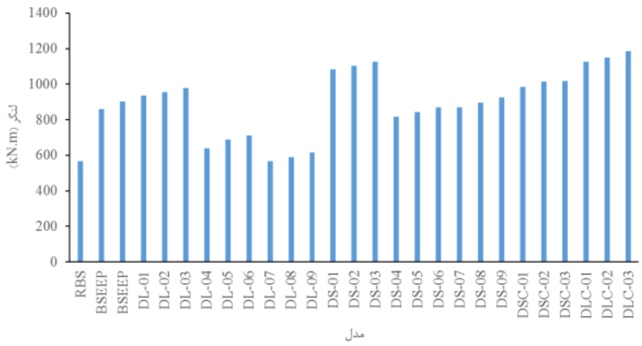

Fig. 3. Anchor comparison chart

Table 3 for the models are:

The hardener is considered as shield and corner

The thickness of the hardener is considered in three categories: 15, 18, and 20 mm. Three categories are set from weak to strong, and in this case, the percentage of increase in hardness and ductility along with resistance is obtained.

According to the above parameters, the number of models is 26.

Of the 6 column models filled with concrete, the compressive strength of concrete is 25 MPa.

In the table below, the specifications of the studied models are shown along with their names.

Loading is also applied from the protocol shown in Figure 3, this protocol is based on ANSI/AISC341-10 standard [4]. ST37 steel is used for the beam and column materials. Figure 1 shows the support conditions and loading method.

2- 1- Comparison of stresses

In this section, the stresses created in some models are displayed based on the applied load. In Figure 2, the Mises stress resulting from the software is displayed.

According to Figure 2, as can be seen in the place of the beam from where the stiffener is placed, the tension in the beam has increased from all points, and this tension has continued up to 200 cm from the place of the beam. And it happened in the flange and web of the beam. The highest amount of stress occurred in the protected area of the beam. As can be seen from the figures, in addition to the buckling stress, distortion also occurred in the RBS connection. Shrinkage has also occurred in the BSEEP connection at the end of the hardener. Summary. Using the numerical results obtained from the Abaqus software, the diagram and numbers related to the maximum anchor have been extracted. In Figure 3, a comparison has been made between the anchor diagram. This comparison is done in several categories.

Figure 3 shows the comparative diagram of anchor models. In the comparison made between the model with concrete and without concrete, it can be seen that the model with concrete has between 7 and 18% higher capacity than without concrete. Comparing the results of the BSEEP connection where two types of BOX and I-shaped columns are placed, it can be seen that the BOX-shaped column has a 10% higher bearing capacity. In Figure 4, the model with the best result is compared with the model with the worst result.

As can be seen, in the diagram the DS03 model has tolerated more anchor and this has led to an increase in energy absorption and the area under the curve. On the other hand, in this chart model, there has been an increasing trend. In the DS03 model, the diagram shows an increase in the load-bearing capacity of the anchor, and less deterioration has been observed in the anchor part.

3- Conclusion

the area under the pre-approved connection curve is smaller than the proposed connection, on the other hand, the

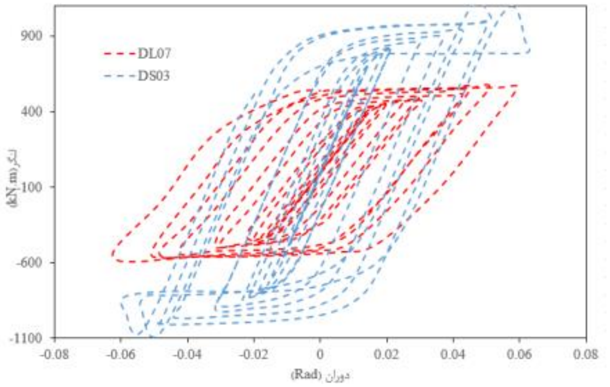

Fig. 4. Comparison between the best model and the worst model of the studied shield and corner

tolerable anchor of the proposed connection is less than the connection of the tenth subject. According to the figure, it can be seen that the ductility in the proposed joint is equal to the joint of the tenth subject. In the proposed connection, the drop and deterioration of resistance have been less. While in the connection of the 10th topic, the drop and deterioration of the resistance of the 10th topic connection has been high. Finally, considering the easy implementation of the proposed connection compared to the connection of the 10th topic, it can be said that the performance of the proposed connection is suitable and better than the 10th topic of the national regulations In all studied connections, the stress in the protected area of the beam and along this distance is higher than the other points. In the pre-approved RBS connection, buckling and distortion occurred in addition to the tension in the beam. Shrinkage has also occurred in the BSEEP connection at the end of the hardener. One of the features of the proposed connection is that the local stiffness in one area is not as high as the BSEEP connection in one area, therefore this local stiffness has caused buckling in the model, this is not observed in the proposed connection due to the more uniform stiffness. In addition, buckling has occurred in the RBS connection due to the decrease in stiffness. Therefore, one of the weaknesses of connection is the reduction of stiffness or the increase of local stiffness in one area of the connection.

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